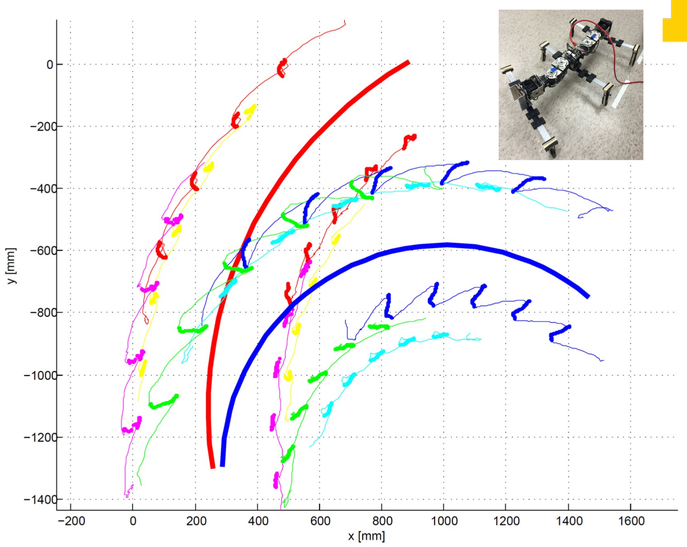
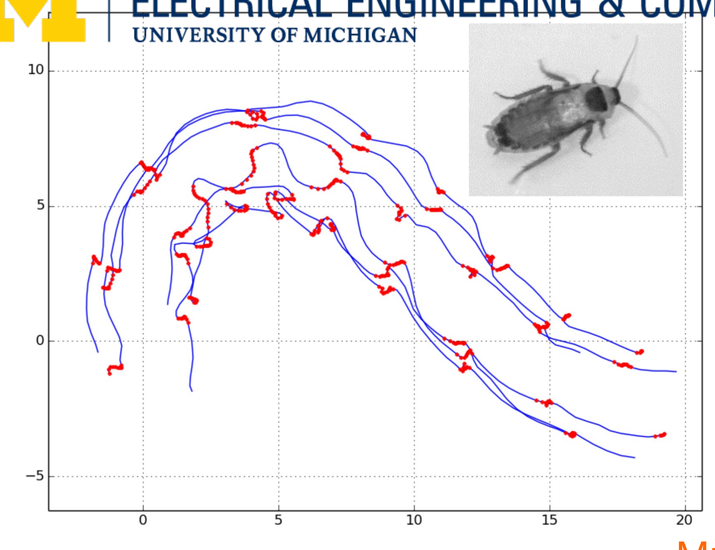
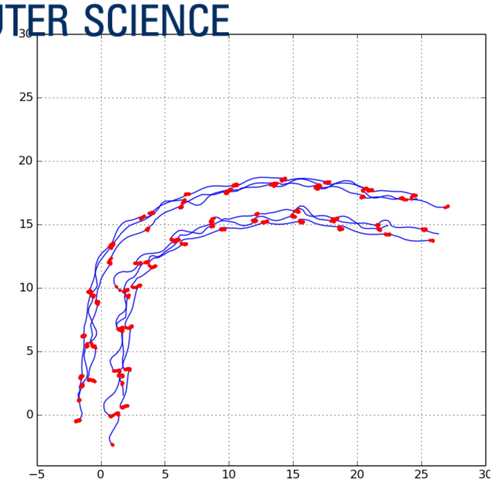
COLLEGE OF ENGINEERING
ELECTRICAL ENGINEERING & COMPUTER SCIENCE
UNIVERSITY OF MICHIGAN



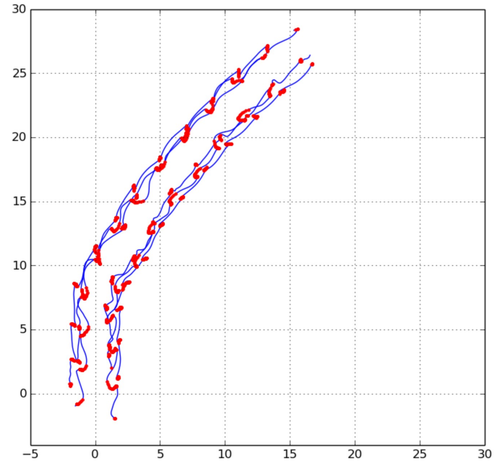
Foot trajectories in world frame



Foot trajectories in world frame



Experiment result



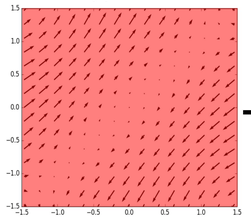
Simulation result

Multilegged Slipping – a high friction limit (Zhao, Heo, Revzen)

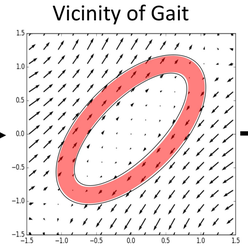
Geometric gait optimization (Hatton) with Data Driven Floquet Analysis (Bittner, Revzen, Hatton)

Modeling Connections about Gaits

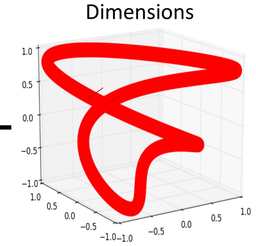
Exhaustive Empirical Approach



Build Connection in Vicinity of Gait



Bigger Win in Higher Dimensions



Given a physical system with i dof: $b_i \in \mathcal{B} \subseteq \mathbb{R}^i$

Assume we have a periodic gait:

$$\theta \coloneqq \mathbb{R} \to \mathcal{B}, \text{where } \exists T > 0 \; s.t. \; \forall t \in \mathbb{R}: \theta(T+t) = \theta(t)$$

Real systems don't strictly follow θ:

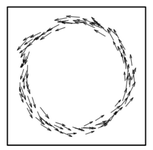
$$\delta \coloneqq \mathbb{R} \to \mathcal{B}, \; \delta = r(t) - \theta(t)$$

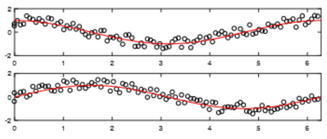
The connection written as perturbations from θ:

$$\xi^k = A_i^k(\theta+\delta)\left(\dot{\theta}+\dot{\delta}\right)^i$$

1st order Taylor Series centered on θ:

$$\xi^k \approx A_i^k(\theta)\dot{\theta}^i + A_i^k(\theta)\dot{\delta}^i + \left(\frac{\partial A_i^k}{\partial r}\right)_j(\theta)\dot{\theta}^i\delta^j + \left(\frac{\partial A_i^k}{\partial r}\right)_j(\theta)\delta^j\dot{\delta}^i$$

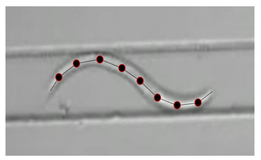




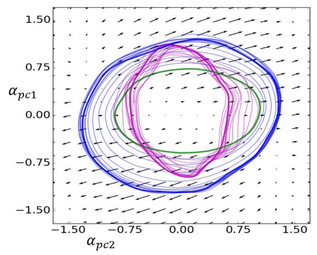
Gait Selection in C. elegans

What are the prime motivators in observed organism behavior?

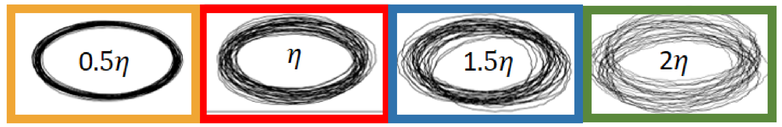
- We approximated high density motion capture data as a nine-link Purcell Swimmer.

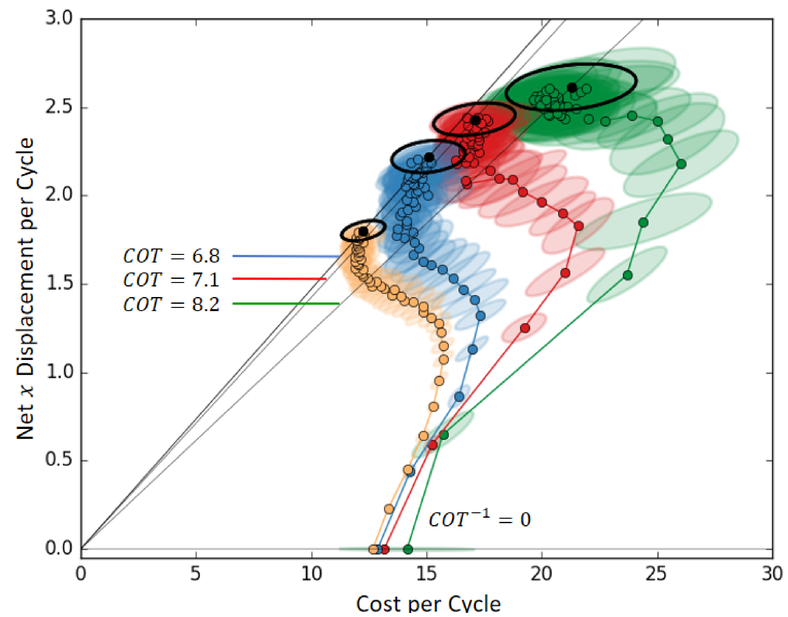


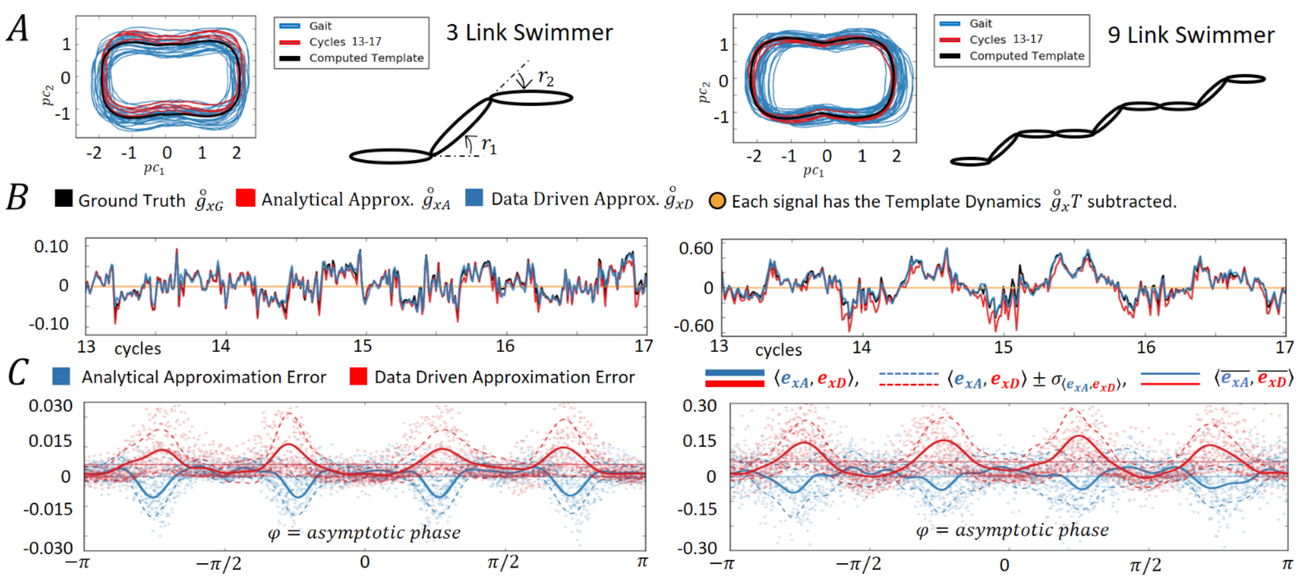
C. elegans Swimming Data: Penn Complex Fluids Lab

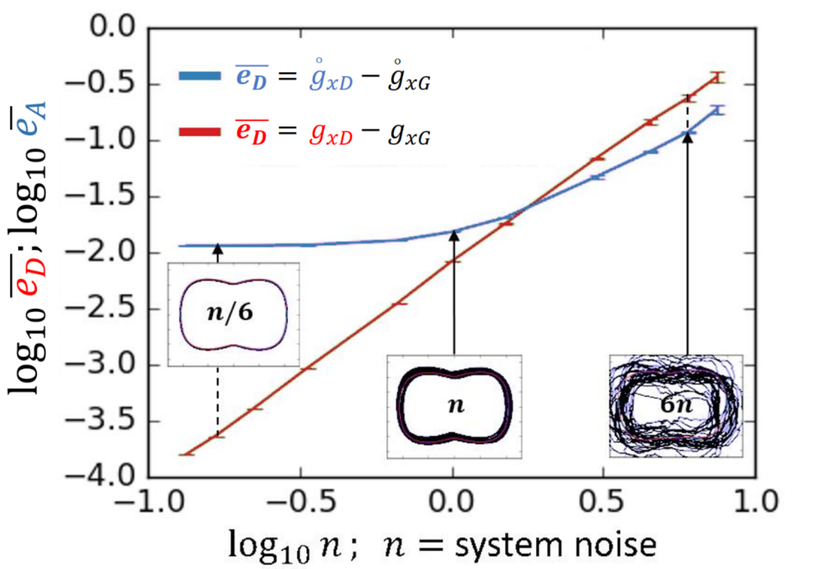


- Initial results show that nematode gaits more closely resemble a low cost of transport gait.









Revzen, 2017 Funding; ARO #W911NF-14-1-0573